THE ROLE OF NONCONTINGENT ATTENTION IN THE TREATMENT OF SELF-INJURIOUS BEHAVIOR MAINTAINED BY POSITIVE REINFORCEMENT

By

TIMOTHY R. VOLLMER

A DISSERTATION SUBMITTED TO THE GRADUATE SCHOOL
OF THE UNIVERSITY OF FLORIDA IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

UNIVERSITY OF FLORIDA

1992

ACKNOWLEDGEMENTS

I would like to thank my committee members Marc Branch, Vivian Correa, Timothy Hackenberg, and Carol VanHartesveldt for the roles they have played, each in a different way, in my education. I would also like to thank Ed Malagodi and Henry Pennypacker, who served on my master's thesis committee, and who also have played instrumental roles in my education. I would especially like to thank my committee chair Brian Iwata for the incredible amount of time and energy he has devoted to shaping my academic, research, and "behavioral" repertoires.

Several of my fellow students have assisted me in ways that made it possible to complete this study. Jodi Mazaleski, Richard Smith, and Jennifer Zarcone all participated as experimenters and contributed greatly to the conceptual framework. Beth Duncan, Dorothy Lerman, Teresa Rodgers, and Bridget Shore all served as observers and contributed immensely with data calculation and helpful ideas. I also would also like to thank the three women who participated as subjects in this study; I will remember them always.

From a personal standpoint, my wife Amy deserves special thanks for her patience and support throughout my graduate career. Without her I might never have had the courage to enroll in graduate school and dedicate the time that is necessary to be successful.

Finally, as I am sure many behavior-analysis graduate students have done in the past year, I would like to extend a special appreciation and dedication of this research to B.F. Skinner.

TABLE OF CONTENTS

Abstract of Dissertation Presented to the Graduate
School of the University of Florida in Partial
Fulfillment of the Requirements for the
Degree of Doctor of Philosophy

THE ROLE OF NONCONTINGENT ATTENTION IN THE TREATMENT OF SELF-INJURIOUS BEHAVIOR MAINTAINED BY POSITIVE REINFORCEMENT

By

Timothy R. Vollmer

May, 1992

Chairman: Brian A. Iwata
Major Department: Psychology

Self-injurious behavior (SIB) is a severe behavior disorder displayed primarily by developmentally disabled individuals. The behavior has been shown to serve several functions, and it can be inadvertently reinforced in several ways: by attention from caregivers, by escape from aversive situations, and/or by physically producing pleasing or pain-attenuating consequences. This study focused on the treatment of individuals whose SIB was maintained by attention as a positively reinforcing consequence. First, three such individuals were identified using a functional analysis approach during assessment. Next, each of the subjects was exposed to two different treatments: Noncontingent attention and differential reinforcement of other behavior (DRO). Previous work with noncontingent reinforcer delivery (NCR) had rarely resulted in successful treatment of behavior disorders.

Both treatments were successful, probably in part because the behavioral function of SIB had been identified prior to treatment. Noncontingent reinforcement is discussed as a preferred treatment because many of the strengths of that procedure address limitations of DRO along various dimensions such as side effects, difficulty of implementation, and relative rate of reinforcement.

INTRODUCTION

The following study examined the effects of two treatment procedures, differential reinforcement of other behavior (DRO) and noncontingent reinforcement (NCR), on self-injurious behavior (SIB) maintained by socially-mediated positive reinforcement. In this introduction, four areas of literature will be reviewed: SIB, functional analysis of behavior disorders, DRO, and NCR.

Self-injurious Behavior

Self-injury is a bizarre, dangerous, and often intractable behavior that has been defined as "behavior which produces physical injury to the individual's own body." (Tate & Baroff, 1966, p. 281). SIB is typically characterized as repetitious and chronic (Favell et al., 1982), and is distinguished from other stereotypies due to its harmful effect. Although self-injury has been noted in normally developing infants and toddlers (e.g., DeLissovoy, 1962), the problem is most severe among individuals with developmental disabilities. Prevalence statistics have estimated that anywhere from 8-14 percent of institutionalized developmentally disabled persons display SIB in one form or another (Griffin, Williams, Stark, Altmeyer, & Mason, 1986; Maisto, Baumeister, & Maisto, 1978; Schroeder, Schroeder, Smith, & Dalldorf, 1978).

Researchers have examined a wide range of behavioral topographies defined as SIB, including head-banging and head-hitting (Romanczyk & Goren, 1975), self-

biting (Luiselli, 1986), self-scratching (Cowdery, Iwata, & Pace, 1990), and eye-gouging (Favell, McGimsey, & Schell, 1982), among many others. Such behavior can result in either immediate (e.g., open sores) or long-term physical damage (e.g., retinal detachment). Certainly such behavior is among the most challenging and severe displayed by any client population studied and treated.

Theoretical orientations and attempts to understand and treat SIB also have taken many forms. Some reviewers (e.g., Favell et al., 1982; Johnson & Rea, 1986) have separated analysis and treatment of SIB into several general classes, two of which are predominant in the current literature: medical and behavioral. Medical disorders highly correlated with SIB include Cornelia de Lange Syndrome (Bryson, Sakati, Nyhan, & Fish, 1971), Lesch-Nyhan Syndrome (Nyhan, 1976), and Otitus Media (DeLissovoy, 1963). Other medical disorders, such as PKU and autism, are indirectly correlated with SIB becuase of their association with developmental retardatation. Medical orientations to SIB are often aimed at the neurochemical level, and involve efforts to treat the syndrome associated with self-injury.

The identification of medical syndromes is a positive step toward developing treatment based on the etiology of SIB; however, only a small proportion of SIB has been shown to be related to specific medical conditions. Furthermore, research has shown that behavior originally brought about by a medical condition can enter into socially-mediated contingencies and can be maintained even after the presenting condition has been alleviated (e.g., Carr & McDowell, 1980). Because most SIB is not correlated with medical disorders, many researchers now consider the possibility that SIB is a learned response. Such an approach is predicated on years of research on operant behavior, which has demonstrated that much of human behavior is influenced by its environmental antecedents and consequences. It is important to recognize that researchers who emphasize an operant approach are not necessarily

"at odds" with medical researchers because, despite the contention of some writers that medical and behavioral interpretations of SIB are contrasting viewpoints (e.g., Whitman, Scibak, & Reid, 1983), it is likely that operant approaches to SIB can accomodate and even facilitate medically-oriented approaches (and vice versa). For example, a behavioral approach to SIB arising from a skin condition might consider the attenuation of an aversive itching sensation as a maintaining variable for self-scratching; treatment for that behavior would require a recognition of the medical condition as well as an understanding of behavioral processes that might maintain dangerous forms of scratching.

An operant approach is appealing because it can readily incorporate socially-mediated consequences of SIB, along with consequences associated with disease or physiology, into a general theoretical framework--whereas a strictly medical interpretation cannot easily do so. Just as SIB can produce physiologically stimulating or pain-attenuating events (such as reduced itching), SIB might produce particular consequences from the social environment-- such as attention or escape from social situations, which might function as reinforcers for self-injury. By definition, individuals who are developmentally disabled sometimes have extremely limited behavioral repertoires, and severe forms of behavior might become predominant due to the high likelihood of generating a response from the social environment. A more thorough description of the general operant framework is described next.

Functional Analyses of Behavior Disorders

There are several potential behavioral functions of SIB. Reinforcing consequences of SIB might be produced either as an automatic physical consequence of the behavior, or they may be mediated by the social environment. Furthermore, such consequences might be either positively reinforcing insofar as a particular stimulus is produced contingent on SIB, or negatively reinforcing insofar as a particular stimulus is avoided, escaped, delayed, or reduced contingent on SIB.

Behavior that automatically produces its own reinforcers has commonly been referred to as "self-stimulatory," or "stereotyped" behavior (Carr, 1977), and is typified as repetitive responding that persists independent of a social environment. It is possible that individuals who live in unusually barren environments or who have limited access to stimulation due to physical disabilities or sensory impairments might begin to engage in SIB as a means of producing sensory stimulation (Lovaas, Newsom, & Hickman, 1987). If the response has its effect by producing stimulation, the behavior is maintained by automatic positive reinforcement. The automatic products of behavior can also offset or delay aversive stimulation (negative reinforcement). For example, as suggested previously, self-scratching may attenuate itching. Additionally, behavior such as ear hitting or eye poking could conceivably be maintained by the "automatic" offset or reduction of ambient environmental stimulation such as loud noise, bright lights, or an otherwise over-stimulating situation.

Socially-mediated reinforcement is defined as consequences provided by others that increase the future likelihood of the response. Socially-mediated negative reinforcement often takes the form of termination of interpersonal interactions following the occurrence of SIB or other aberrant behavior (Carr, Newsom, & Binkoff, 1976). Several studies have shown that escape from learning-trial

demands can function to maintain SIB, and when escape is prevented (i.e., extinction is in effect) behavior decreases (e.g., Iwata, Pace, Kalsher, Cowdery, & Cataldo, 1990).

Particularly relevant to the current study is the fact that some SIB is maintained by socially-mediated positive reinforcement (i.e., attention). Behaviors such as aggression, disruption, and SIB are particularly susceptible to socially-mediated positive reinforcement because the responses often require attention from caregivers. For example, caregivers are likely to express statements of concern or disapproval, or even to physically intervene in an attempt to abate the behavior. Similarly, it is possible that caregivers might provide the individual with access to preferred items such as food or toys, contingent on SIB in order to "calm the person down." Unwittingly, these caregivers may be increasing the future likelihood of SIB because their attention functions as positive reinforcement, particularly if the client is not equipped with alternative means of seeking attention. One of the earliest studies to demonstrate the reinforcing effect of attention on SIB was reported by Lovaas and Simmons (1969). When attention was provided contingent on SIB, the rate of behavior increased markedly over levels when behavior was ignored. Such findings are not idiosyncratic; a recent behavioral-epidemiological report suggests that the sensitivity of SIB to social positive reinforcement is not rare at all--approximately 23% of functional analyses (see below) identify some form of attention as a variable maintaining SIB (Iwata et al., 1991).

Because SIB can serve a variety of functions, methods for identifying those functions are useful prerequisites to effective treatment. The initial study describing a general method for identifying the functions of aberrant behavior was reported by Iwata, Dorsey, Slifer, Bauman, and Richman (1982). Subjects were exposed to a variety of conditions to determine if SIB was sensitive to particular

sources of reinforcement. One condition arranged for therapist attention as a consequence for SIB (test for social-positive reinforcement), another arranged for contingent escape from instructional demands (test for social-negative reinforcement), and another involved leaving the subject alone with no programmed consequences for SIB (test for automatic reinforcement). The experimenters also included a "play" condition, which served as a control for each of the other three conditions because attention was presented frequently, no instructional demands were presented, and the environment contained leisure and play materials (alternative stimulation). The results demonstrated that SIB served specific functions (e.g., escape, attention-getting, self-stimulation) for different individuals insofar as the frequency of SIB varied systematically within subjects and across conditions. This finding is especially relevant to the development of treatment procedures because a functional analysis can identify reinforcers that can maintain behavior, and hence suggests a treatment protocol utilizing those reinforcers to develop appropriate behavior, while simultaneously extinguishing targeted aberrant behavior.

A considerable amount of research has replicated the utility of functional assessment procedures, and several studies have used such assessment procedures to develop treatment based on behavioral function (see Iwata, Vollmer, & Zarcone, 1990, for a review). Surprisingly little research has emerged using information obtained in a pretreatment functional analysis to develop treatment for SIB that is maintained by positive reinforcement. The next section, in the context of describing DRO and NCR procedures, discusses the logic of matching treatment function (positive reinforcement) to suspected behavioral function (positive reinforcement).

Treatment of Behavior Maintained by Positive Reinforcement

Positive reinforcement procedures, as a general class, are probably the most widely used techniques for decreasing undesirable behavior in people who are developmentally disabled (Lennox, Miltenberger, Spengler, & Erfanian, 1988). Typically, these reinforcement-based procedures involve some variation of differential reinforcement, and DRO is perhaps the most commonly used procedure in clinical settings. The widespread application of positive reinforcement as treatment does not necessarily mean that behaviors treated were initially maintained by positive reinforcement--recall that few studies have identified positive reinforcement as a maintaining variable and then used positive reinforcement during treatment. To emphasize the possible importance of matching treatment function to behavioral function, some background information about DRO and NCR will be provided.

Differential Reinforcement of Other Behavior (DRO)

Procedurally, DRO involves the delivery of reinforcement contingent on the absence of a target response for a pre-specified interval of time. Such schedules were first examined extensively by Reynolds (1961); the experimental component relevant to this discussion was a condition in which pigeons received food if they did not engage in a key-peck for a fixed period of time. Key-pecking eventually fell to low rates in that DRO condition.

Reynolds' terminology (DRO) has not been universally adopted because it implies non-behavior as a response class, which appears inconsistent with Skinner's (1953) definition of reinforcement based on increased probability of future responses. Because occurrence of the target response reduces reinforcement frequency, Uhl and Garcia (1969) renamed DRO procedures omission training.

Others (e.g., Poling & Ryan, 1982; Zeiler, 1970) prefer the term differential reinforcement of not responding, or zero responding, arguing that non-responding is in fact a modifiable unit and hence a response class. Interresponse times (IRTs) are quantitative dimensions of behavior (Malott & Cumming, 1964), and this lends credence to the "zero responding" terminology (for a further discussion on this topic see Rolider & Van Houten, 1990). There is, thus, some debate about the most appropriate terminology in discussing such procedures, but the term DRO appears most consistently in the literature.

The relevance of Reynolds' (1961) procedure to human behavior was noticed quickly by applied researchers. One of the earliest applications was by Allen and Harris (1966) who trained a mother to use a DRO-like schedule to reduce her child's self-scratching while reinforcing other behavior at specified intervals. Similarly, Patterson, Jones, Whittier, and Wright (1965) and Doubros and Daniels (1966) used DRO schedules to reduce hyperactive behavior in developmentally-delayed children.

One procedural consideration in developing DRO procedures involves setting an appropriate DRO time interval. There is no well-established rule for determining the initial DRO interval (Poling & Ryan, 1982), although Deitz and Repp (1983) suggested a formulation based on the mean IRT established during baseline. For example, if SIB occurred at an average rate of 6 responses per minute during baseline, the mean IRT would be 10 seconds; hence, the initial DRO interval would be set at approximately 10 seconds. Such a formula was employed by Repp, Deitz, and Spier (1974) and has proven useful in subsequent applications. The formula is appealing because it virtually guarantees that the behavior will contact the reinforcement contingency on some percentage of the intervals. On the other hand, if

extinction bursts (marked increases in frequency of behavior when reinforcement is witheld) occur early in intervention, the rate of reinforcement might be rather low.

Once the initial DRO interval is established, a reasonable practical goal is to increase interval duration across sessions, as in escalating interval schedules, in order to arrive at a more naturalistic and pragmatically useful interval (Cooper, Heron, & Heward, 1987). Poling and Ryan (1982) suggest three techniques for increasing the interval across sessions: (1) in fixed increments, (2) in proportional increments, and (3) in increments based on the subject's recent performance. An example of increasing in fixed increments would entail adding ten seconds to the interval after each session that a specified rate criterion was met. Proportional incrementation would involve increasing the interval by, say, ten percent of the current interval upon meeting the rate criterion. An example of the third technique would involve an IRT-adjusting schedule, wherein the criterion IRT's are updated following each session or group of sessions; DRO intervals are thus determined according to a formula similar to the Deitz and Repp (1983) formula based on the most recent response rates.

A common aspect of the DRO procedure is its "resetting" feature, which is derived directly from the Reynolds (1961) study. In this procedure, the target response resets the DRO timer to zero. For example, Repp et al. (1974) reduced stereotypic behavior of retarded persons by providing reinforcers after some set period of time had elapsed since the previous occurrence of stereotypy. Thus, the predetermined interval between the target response and reinforcement was held constant (response-reinforcer intervals). This type of schedule is usually accomplished when an occurrence of the target response is used as a cue for resetting a timer; the timer elapsing is a cue for reinforcement delivery. Schedules can also be arranged without a resetting feature (e.g., Repp, Deitz, & Deitz, 1976), such that the target

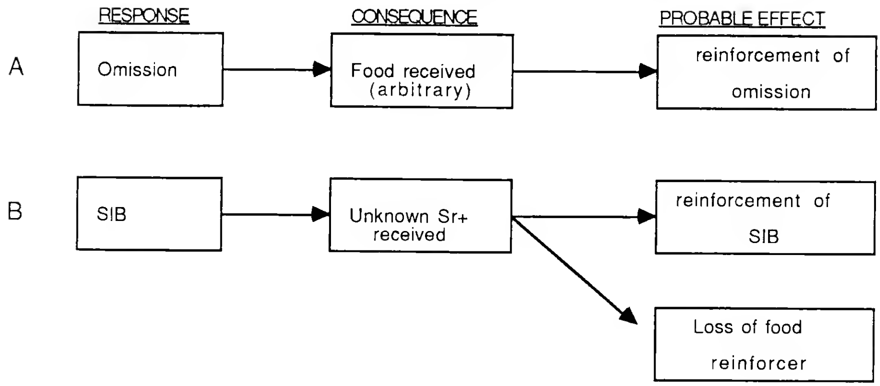
response eliminates the possibility of obtaining reinforcement for an entire interval.

DRO is especially relevant to the treatment of positively reinforced behavior. For example, if attention is identified as a reinforcer for SIB, attention can be provided contingent on the absence of SIB, which would no longer produce the reinforcing consequence. This arrangement ensures that a functional reinforcer is provided for the absence of SIB, and that extinction is in effect for SIB. Prior to the recent application of functional analysis procedures, DRO treatments typically involved reinforcers that were arbitrary in relation to behavior-- such as using food reinforcers when the function of SIB is unknown (e.g., Corte, Wolf, & Locke, 1972). With the information obtained through a functional analysis, DRO procedures can be prescribed appropriately for client's whose SIB has been shown to be positively reinforced. To date, few applications of DRO have been reported that were explicitly based on a pretreatment functional analysis, although research involving differential reinforcement of alternative behavior (DRA, a closely related procedure) suggests that applications of DRO would be successful if a functional analysis is conducted (e.g., Day, Rea, Schussler, Larsen, & Johnson, 1988).

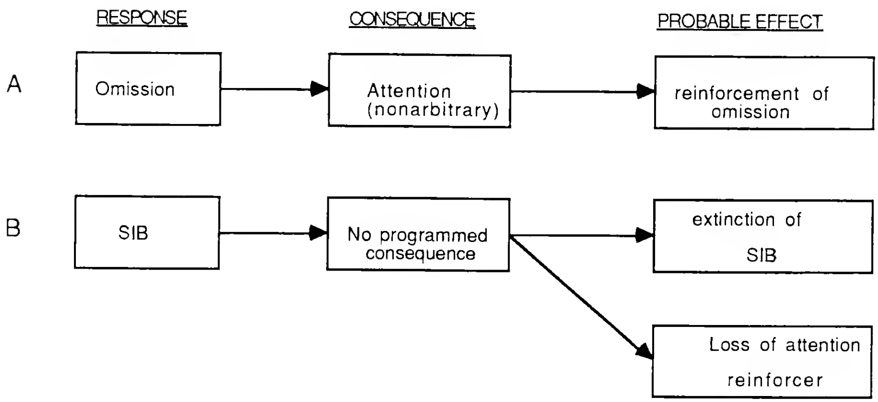
Figure 1 diagrams two hypothetical situations comparing the available schedules of reinforcement during DRO using arbitrary reinforcers (upper panel) versus DRO using nonarbitrary reinforcers (lower panel). For the purposes of this example, food will be considered an arbitrary consequence (not responsible for maintaining SIB) and attention a nonarbitrary consequence (responsible for maintaining SIB). The effectiveness of DRO using arbitrary reinforcers depends entirely on competition between the arbitrary stimulus and the relevant maintaining reinforcers (that are unknown in the absence of a functional analysis), and some amount of behavior is likely to be allocated toward obtaining reinforcers of each

Figure 1. Diagram comparing the available schedules of reinforcement in DRO using arbitrary reinforcers (upper panel) versus DRO using nonarbitrary reinforcers (lower panel). The rows marked "A" indicate the schedule in effect for the omission of a target response. The rows marked "B" indicate the schedule in effect for SIB.

DRO WITH ARBITRARY REINFORCING STIMULUS



DRO WITH NON-ARBITRARY REINFORCING STIMULUS



type. DRO using nonarbitrary reinforcers is more likely to be effective because reinforcement is no longer available for SIB (i.e., extinction is in effect) and because the reinforcer previously available contingent on SIB is now available contingent on the absence of SIB; hence there is no competition between the concurrent SIB and the omission schedules.

Apart from the apparent functional utility of DRO, there are several other potential advantages to differential reinforcement, relative to other behavior-reduction procedures. First, differential reinforcement has successfully treated a wide range of behavior disorders (whether as a single treatment or in conjunction with other procedures), including self-injury (Cowdery et al., 1990), disruptive behavior (Bostow & Bailey, 1969), stereotypy (Repp et al., 1974), and aggression (Repp & Deitz, 1974), among others (see Homer & Peterson, 1980). Additionally, positive reinforcement procedures do not involve the contingent delivery of aversive stimulation (as punishment procedures do). Finally, procedures like differential reinforcement do not involve removing an individual from an educative environment (as timeout procedures do).

Despite the wide acceptance of differential reinforcement, and despite the positive results across a wide range of topographies, some potential drawbacks exist. First, several reviews have concluded that the procedure can be relatively ineffective in treating the most severe behavior disorders (such as self-injury) when compared to other behavior-reduction procedures (e.g., Favell et al., 1982; Romanczyk, 1986). Second, undesirable side-effects have been reported, including emotional behavior (Cowdery et al., 1990) and aggression (Lennox, Miltenberger, & Donnelly, 1987); these undesirable side-effects are possibly related to the extinction component of differential reinforcement schedules. Third, differential reinforcement procedures can be cumbersome to administer over long periods of

time because they often require continuous monitoring of a client's behavior. For example, DRO procedures usually require a caregiver to reset an interval timer following each occurrence of the target response. Such a procedure can be difficult if the caregiver is a parent with other household duties, or institutional staff with other clients to assist (Boe, 1977). Finally, DRO procedures can result in relatively low rates of reinforcement, particularly when behavior occurs at a high frequency (as many behavior disorders, such as SIB, typically do)--this is troublesome because many developmentally disabled people do not receive much interaction, especially in institutional settings (Reid, Parsons, Green, & Schepis, 1991). A resetting DRO, if followed correctly, can validate or even mandate low frequencies of staff interaction, and create a further deprivation.

It is possible that some of the shortcomings of differential reinforcement procedures, such as ineffectiveness, are technological shortcomings rather than limitations of the procedure per se. For example, because recent research has demonstrated that pretreatment functional analyses improve the likelihood of treatment success, and because most existing research did not involve pretreatment functional analyses, the true potential effectiveness of DRO is unknown (also see Figure 1). Nonetheless, some of the other shortcomings of DRO, such as emotional side effects, warrant examination of other reinforcement-based procedures; one possibility is NCR.

Noncontingent Reinforcement (NCR)

Noncontingent reinforcement can be described as response-independent delivery of stimuli with known reinforcing properties. As with DRO, there are terminological shortcomings in using the phrase "noncontingent reinforcement" because it is not clear what dimension of behavior, if any, is being reinforced.

However, other terms found in the literature (such as "response-independent reinforcement") are also inexact if no reinforcement effect is demonstrated. The term "NCR" will be used in this paper as a label for the procedure, but is not intended to imply any presumed behavioral effect or process.

Noncontingent reinforcement has been studied extensively in basic experimentation. For example, Rescorla and Skucy (1969) compared extinction (by omission of contingent food reinforcer delivery) versus response-independent delivery of food on variable-time (VT) schedules as extinction procedures. They found that extinction by omission decreased behavior (lever pressing in rats) more effectively than VT-extinction, but both procedures resulted in significant decrements. By contrast, some investigators (e.g., Skinner, 1948) have demonstrated that responding can be acquired and maintained using response-independent schedules of reinforcer delivery. However, the generality of such an "adventitious" reinforcement effect is not supported by experimentation showing that response-independent schedules eventually result in decreases in response rates (e.g., Zeiler, 1968).

In applied studies, many behavior-acquisition studies have increased the rate of some desirable behavior using positive reinforcement, and then delivered the reinforcer noncontingently in a reversal condition as a means of suppressing the target response for the purpose of providing a control for the effects of reinforcement (e.g., Azrin, Rubin, O'Brien, Ayllon, & Roll, 1968; Buell, Stoddard, Harris, & Baer, 1968). The suppressive effect of NCR in acquisition studies supports the interpretation of Rescorla and Skucy (1969) that response-independent reinforcer delivery is functionally an extinction procedure insofar as the contingent relationship between response and stimulus is eliminated and the frequency of a target response is subsequently reduced.

As well as having extinction-like features, NCR might serve as an "establishing operation" (an event that alters the reinforcing efficacy of a stimulus, see Michael, 1982) that alters relative deprivation with respect to a given reinforcer. The effects of NCR as an establishing operation were examined by Vollmer and Iwata (1991), who demonstrated that pre-session exposure to noncontingent attention, food, and music, reduced the subsequent efficacy of those stimuli as reinforcement in a skill acquisition task. These findings extend a large body of basic experimentation showing that when stimuli are available on response-independent schedules, the baseline rate of responding is decreased (e.g., Nevin, Tota, Torquato, & Shull, 1990).

As Boe (1977) pointed out, if NCR is effective in decreasing the rate of appropriate responding as a control in acquisition studies, there is no reason to assume it would not also be effective in decreasing the rate of inappropriate responding. Unfortunately, the literature on NCR as treatment for behavior disorders is not encouraging. Several published studies have demonstrated that noncontingent reinforcement is either ineffective, or less effective, in suppressing undesirable behavior compared to other reduction procedures such as differential reinforcement. For example, Corte et al. (1971) showed that DRO with food-reinforcement was more effective in suppressing SIB than noncontingent (time-based) food delivery. Additionally, Goetz, Holmberg, and LeBlanc (1975)--in an examination of reversal/control procedures-- showed that DRO suppressed compliance to requests greater than noncontingent reinforcer delivery.

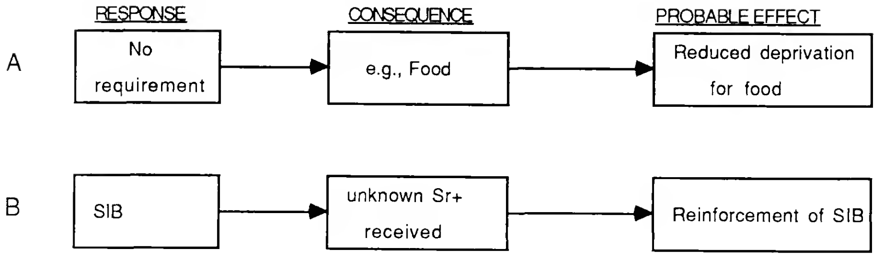
Although it is not entirely clear why DRO was more effective than NCR, in light of the basic literature and in light of the applied acquisition literature, it is possible that the inability to suppress responding effectively through noncontingent reinforcer delivery is an artifact of using arbitrary reinforcers. Specifically, in response acquisition/NCR-control studies, the reinforcer responsible for

maintaining behavior (a nonarbitrary reinforcer) is also introduced as the response-independent stimulus; thus, the contingent relationship between response and consequence is eliminated and deprivation from the reinforcing stimulus is reduced incrementally with each reinforcer delivery. To the contrary, much of the existing behavior-reduction literature involves procedures that take place in the absence of identifying the functional maintaining variables, and hence involve the delivery of arbitrary reinforcers (i.e., those unrelated to the target response). Figure 2 shows that NCR using arbitrary reinforcers (upper panel) produces very different schedules of reinforcement than does NCR using reinforcers responsible for maintaining behavior (lower panel). In NCR using arbitrary reinforcers the relationship between aberrant behavior and the unknown functional consequence is not disrupted and there is no alteration in the relevant establishing operation. In NCR using nonarbitrary reinforcers, the contingent relationship between SIB and the functional consequence is disrupted and there are also potential alterations in the establishing operation such that relative deprivation states are decreased.

It is not surprising, then, that DRO has proved to be more effective than NCR using arbitrary reinforcers because an arbitrary NCR cannot be expected to have large effects on a target response. However, if the comparison DRO is also using an arbitrary stimulus, why should DRO be more effective? Consider the results reported by Corte et al. (1971). Without identifying the maintaining variables for their subjects' SIB, noncontingent reinforcer delivery involved delivering food while SIB was presumably still reinforced (because if the reinforcer is unknown, it cannot be withheld). Figure 3 shows that in DRO using arbitrary reinforcers, the only way to obtain the food reinforcer was to refrain from engaging in SIB. This situation

Figure 2. Diagram comparing the available schedules of reinforcement in NCR using arbitrary reinforcers (upper panel) versus NCR using nonarbitrary reinforcers (lower panel). The rows marked "A" indicate the response independent feature of NCR. The rows marked "B" indicate the schedule in effect for SIB.

NCR WITH ARBITRARY REINFORCING STIMULUS



NCR WITH NON-ARBITRARY REINFORCING STIMULUS

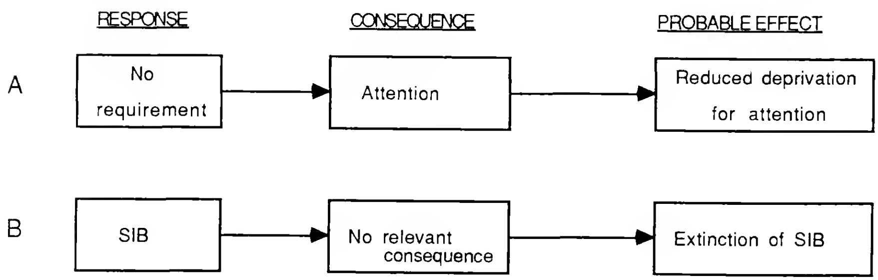
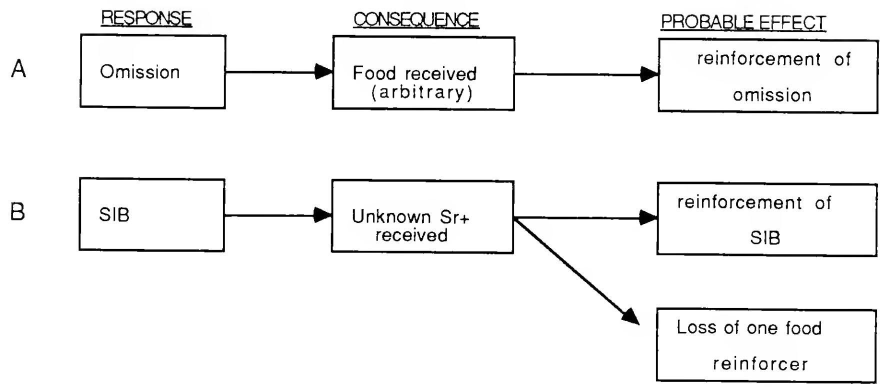
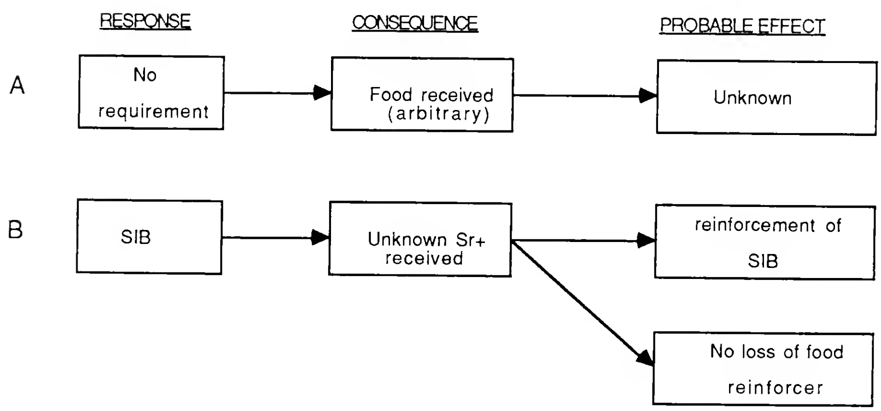


Figure 3. Diagram comparing the available schedules of reinforcement in DRO using arbitrary reinforcers (upper panel) and NCR using arbitrary reinforcers (lower panel). The rows marked "A" and "B" correspond to such rows in the preceding two figures.

DRO WITH ARBITRARY REINFORCING STIMULUS



NCR WITH ARBITRARY REINFORCING STIMULUS



sets up competing schedules of reinforcement for SIB (unknown reinforcer) and non-SIB (food reinforcer), to the extent that food delivery serves as reinforcement, at least some responses would be allocated to the non-SIB reinforcement schedule. However, in the NCR condition, the subjects could obtain both types of reinforcers without food reinforcer loss-- even by continuing to engage in SIB. Thus, although neither procedure could be expected to be entirely effective in comparison to procedures using nonarbitrary reinforcers (because the functional maintaining consequences are still in effect), DRO would probably be more effective than NCR if arbitrary reinforcers are used.

Despite the unsuccessful (however explainable) treatment studies using NCR, some evidence exists suggesting that noncontingent presentation of reinforcers can suppress undesirable behavior, even if the general function of the target behavior is unknown. For example, Boe (1977) decreased aggression in retarded children by presenting a variety of consumable stimuli on a variable-time schedule. Similarly, Horner (1980) decreased a range of maladaptive behaviors by "enriching" the environment of disabled individuals with toys, food, and other materials. More recently, Mace and Lalli (1991) reported a study examining effects of response-independent delivery of attention, following a functional analysis that identified attention as a reinforcer for bizarre vocalizations. In that study, the rate of undesirable vocalizations was substantially reduced when attention was made available on variable-time (VT) schedules. This finding provides empirical support for NCR as a viable treatment for aberrant behavior when behavioral function has been identified.

Statement of Purpose

Because both DRO and NCR are most likely to be effective when behavioral functions have been identified prior to treatment, the effects of those procedures should be experimentally examined. If both procedures are shown to be effective, previously equivocal results can more readily be attributed to the use of arbitrary reinforcers. If NCR is shown to be as effective as DRO, then previous comparisons of the procedures must be viewed with caution because they too used arbitrary reinforcers. In addition, because of the potential limitations of DRO, it is worthwhile to examine the effects of alternative reinforcement-based procedures, such as NCR.

In comparison to DRO, NCR might be useful in attenuating extinction-induced behavior, especially in cases when variations of differential reinforcement, such as DRA, are not immediately possible. Durand and Carr (1991) have pointed out that by making reinforcement differentially available contingent on an alternative response, an individual would not necessarily display an extinction burst because the alternative response might provide an accessible means of obtaining reinforcement. However, for some individuals with extremely limited behavioral repertoires, shaping an alternative response can be time-consuming; therefore extinction bursts might occur when aberrant responding is no longer reinforced. In these cases, NCR might be useful in attenuating extinction-induced behavior because the functional reinforcer can be made available on a relatively rich time-based schedule despite the elimination of a contingent relationship between response and consequence.

Also in comparison to DRO, NCR would be less cumbersome to administer, as continuously monitoring target responses is unnecessary. Furthermore, NCR ensures that the programmed and obtained rate of reinforcement would be the same

or higher than in DRO (given comparably scheduled delivery intervals). Whereas any occurrence of the target response during DRO essentially results in reinforcer loss (Rolider & VanHouten, 1990), NCR schedules are unaffected by client behavior.

Thus, if NCR procedures are found to be effective in decreasing SIB, many of the potential shortcoming of DRO procedures could be circumvented without sacrificing the benefits of a function-based treatment. Therefore, the purpose of the current study is to compare NCR to DRO in order to assess the viability of NCR as a treatment procedure when behavioral function has been identified. Additionally, such a comparison can precipitate evaluation of the relative merits of NCR and DRO in terms of ease of implementation, relative rate of reinforcer delivery, and side effects.

METHOD

Subjects and Setting

Three developmentally disabled adult females, all residents of a public facility, participated in the study. Subjects were selected for participation based on a referral for treatment of chronic SIB, and were screened for inclusion in this study based on the results of an assessment designed to identify the functional properties of their SIB (see procedures).

Diane was a 32-year-old woman diagnosed as profoundly mentally retarded. She had a history of SIB (head hitting, body hitting, head banging) dating back several years, but was generally not aggressive or destructive. She could walk independently, but sometimes required assistance due to balance problems or noncompliance. She displayed a limited verbal repertoire, consisting mostly of imitative vocalizations and some independently-produced manual signs. She did not receive psychotropic medication during the course of this study.

Bonnie was a 40-year-old woman diagnosed as severely mentally retarded. She was referred for treatment due to a long history of chronic hand-mouthing. Hand-mouthing was seen as problematic because it produced tissue damage over long periods of time, limited social interactions, and possibly exposed Bonnie to germs. She also displayed some disruptive and aggressive behaviors. She displayed a limited verbal repertoire consisting of particular words that she repeated almost

continuously, and she also echoed some words produced by caregivers. She did not receive psychotropic medication during the course of this study.

Brenda was a 42-year-old woman diagnosed as profoundly mentally retarded. She was referred for treatment due to an extensive history of severe head-banging and head-hitting, among other SIB. She was also extremely disruptive and sometimes aggressive. She, too, displayed a minimal verbal repertoire consisting of a few modified manual signs to request bathroom breaks, food, or water. She received Haldol (6mg) per day throughout the course of this study; no medication tapers or increases were attempted until following the completion of the experiment.

All sessions were conducted at a day-program unit designed for the analysis and treatment of SIB. Chairs and couches were available in the rooms at all times, but other contents of the room were varied according to experimental conditions. Sessions lasted either 10 minutes (Diane) or 15 minutes (Bonnie and Brenda) and usually took place 5 days per week. Two to four sessions were conducted per day depending on variations in the subjects' daily schedules.

Human Subjects Protection

In order to assess and treat SIB, the experiment required allowing subjects to engage in SIB for brief periods of time. The assessment and treatment protocols were reviewed and approved by an institutional review board, and all procedures were monitored by medical staff when necessary. Several safeguards were established to reduce the risk of injury to the subjects. First, each subject was monitored on a daily basis by medical personnel at their homes (a standard procedure for residents of the facility). Second, session termination criteria were established by a physician (for Diane and Brenda; this was deemed unnecessary for Bonnie). Third,

potentially severe self-injurious responses were partially blocked using a foam pad, which could be used with minimal physical interaction between subject and experimenter. Finally, a physician was available (via beeper) during sessions at all times.

Response Measurement

Topographies of SIB included head-hitting, head-banging, and body-hitting (Diane and Brenda) and hand-mouthing (Bonnie). Head-hitting was defined as forceful contact against the head/face area by any other portion of the body including arms, hands, legs and feet. Head-banging was defined as forceful contact by the head against any hard surface including furniture, the wall, or the floor. Body-hitting was defined as forceful contact against any area of the body other than head/face by any other portion of the body including arms, hands, legs, and feet. Hand-mouthing was defined as intrusion of the hand or fingers into the mouth past the plane from the upper lip to the lower lip; also included was any protrusion of the tongue onto the hand or fingers. Attention was defined as a 10-s verbal interaction between client and therapist; during baseline, attention included expressions of disapproval and concern while lightly touching the client on the shoulder or arm area. During treatment only the verbal content of attention differed from baseline (i.e., statements were not of concern or disapproval, but rather involved statements of praise and general conversation).

The primary dependent variable of interest was responses per minute of SIB. Data were collected using hand held computers. Interobserver agreement was assessed by having a second observer simultaneously but independently record data with a primary observer. Percentage agreement scores were computed by dividing

the sessions into consecutive10-s intervals. The smaller number of observed responses was divided by the larger number of observed responses in each interval, and these values were averaged across the session. Agreement was assessed during 27.7% of the functional analysis sessions, 30% of the baseline sessions, and 25.6% of the treatment sessions for all subjects combined. Agreement for SIB during the functional analysis averaged 93.8% overall, and exceeded 89.5% for each individual subject. Agreement for SIB during baseline sessions averaged 91.7% overall, and exceeded 89.3% for each individual subject. Agreement for SIB during treatment sessions was 96.0% overall, and exceeded 94.5% for each individual subject. Agreement on the delivery of attention exceeded 98% during baseline and treatment for all three subject.

Procedures

Functional Analysis

The functional analysis was based on procedures described by Iwata et al. (1982). A series of conditions was presented in multielement format to each subject independently. Briefly, these were: (a) alone-- Subjects were observed alone in a room without access to stimulatory items, and no social consequences were placed on SIB. The purpose of this condition was to identify whether a subject's SIB was maintained independent of social consequences; (b) attention--leisure activities were available to the subject, although the experimenter did not attend to her except to deliver reprimands and/or statements of concern contingent on SIB. The purpose of this condition was to determine if a subject's behavior was sensitive to attention as a positively reinforcing consequence of SIB; (c) demand--the experimenter presented instructional trials to a subject on fixed-time (FT) 30-second schedule, and a timeout was made contingent on SIB. The purpose of this condition was to assess

behavioral sensitivity to escape from instructional demands; (d) play--the experimenter provided opportunities for interaction and stimulation contingent on the absence of SIB (essentially on a 30-s fixed time schedule, with a 5-s DRO during the final 5-s). The purpose of this condition was to observe the rate of SIB in an enriched environment; in a sense, this condition served as a control condition.

Treatment Comparison

For each subject, baseline contingencies were identical to the "attention" condition described in the functional analysis. Additionally, for Diane and Bonnie, two experimenters alternated in conducting baseline sessions. Following baseline, subjects were exposed to two treatment conditions: DRO and NCR. For Diane and Bonnie, treatment effects were compared in a multielement within-subjects design and multiple baseline across-subjects design. One experimenter was correlated with the DRO condition, another with the NCR condition (hence the need for alternating experimenters in baseline-- to control for experimenter-specific effects). For Brenda, one experimenter conducted all sessions, and the treatments were compared using a reversal (A-B-A-C) design, in which the "B" condition consisted of NCR and the "C" condition consisted of DRO.

DRO. During DRO sessions, the experimenter delivered attention according to a resetting interval schedule, in which any SIB reset the DRO timer. If the subject did not engage in SIB during an interval, attention was delivered. Each interaction between the experimenter and subject lasted 10 seconds. Prior to each session, the DRO interval length was determined by computing the mean interresponse time

(IRT) for the preceding X sessions (X=3 for Diane, X=5 for Bonnie and Brenda). However, the DRO interval was never decreased even if mean IRTs became shorter (i.e., the schedule could never "back up"). Thus, if the rate of SIB was reduced, the mean IRT was increased, and hence the DRO interval was increased. At some points during the experiment, the mean IRTs stopped getting longer; in these cases, the interval was advanced (to the nearest minute) when the rate of SIB fell within the range of several preceding sessions. The eventual goal for the DRO condition was to establish a 5-minute DRO interval while maintaining low rates of SIB.

NCR. During NCR sessions, the experimenter delivered attention on a fixed-time schedule; the subject's behavior did not influence the schedule of reinforcer delivery. As with DRO, each interaction between experimenter and subject lasted 10 seconds. Prior to each session, the fixed-time schedule was determined according to pre-established fading criteria. The schedule was faded from a rate of 6 per minute (continuous attention) to a rate of 0.2 per minute (one delivery per five minutes). This fading was accomplished by deleting one interaction per minute from the schedule after the rate of SIB was at or below 0.5 responses per minute during any given session. Also, after the rate of attention delivery was reduced to 1 per minute, the schedule was faded first to 0.5 per minute, then 0.33 per minute, then 0.25 per minute, and finally 0.2 per minute. At times (in Bonnie's case), the fading of the fixed-time schedule was based on the observation that her rate of SIB was within the range of several preceding sessions (because it was rarely 0.5 per minute or lower; see results).

RESULTS

Functional Analysis

Figure 4 displays the results of Diane's assessment. With the exception of one demand and one play session, rates of SIB were consistently higher in the attention condition when compared to other conditions. In the attention condition, the rate of SIB ranged from approximately 0 responses per minute to approximately 15 responses per minute. In the other conditions, SIB generally ranged from about 0 to about 3 responses per minute. These results showed that Diane's SIB was differentially sensitive to attention as a positive reinforcer.

Figure 5 displays the results of Bonnie's assessment. The rate of SIB was consistently higher during attention sessions, and ranged from approximately 3 responses per minute to approximately 8 responses per minute. During demand, alone, and play sessions, the rate of SIB ranged from slightly more than 0 responses per minute to approximately 3 responses per minute. As with Diane, these results showed that Bonnie's SIB was differentially sensitive to attention as a positive reinforcer.

Figure 6 displays the results of Brenda's assessment. The rate of SIB was consistently higher during the attention sessions, and ranged from approximately 4 responses per minute to approximately 10 responses per minute. In all other conditions, the rate of SIB ranged from approximately 1 response per minute to approximately 3 responses per minute. Again, these results show that SIB was

Figure 4. Responses per minute (SIB) during the functional analysis of Diane's SIB.

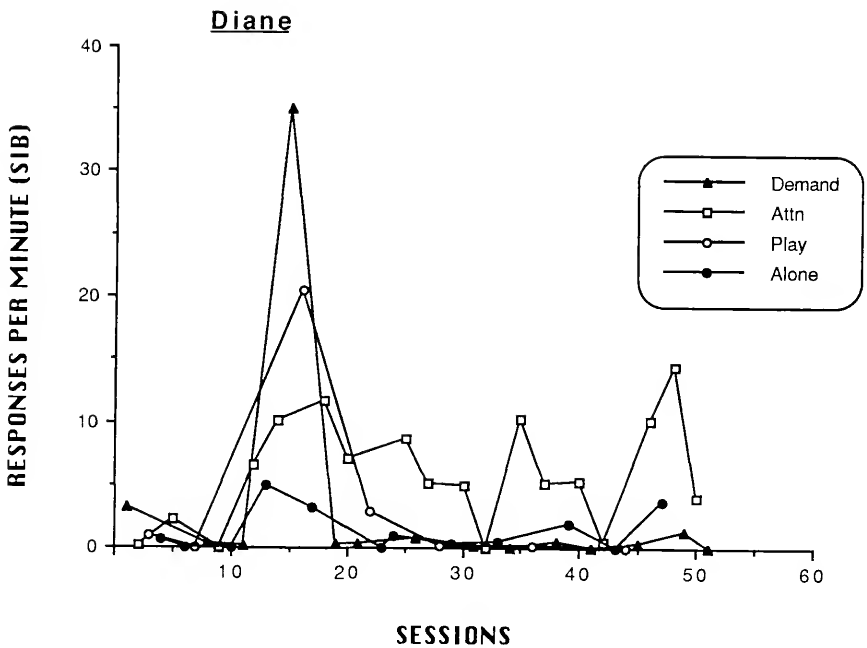

Diane
RESPONSES PER MINUTE (SIB)
40
30
20
10
0
10
20
30
40
50
60
SESSIONS
Demand
Attn
Play
Alone

Figure 5. Responses per minute (SIB) during the functional analysis of Bonnie's SIB.

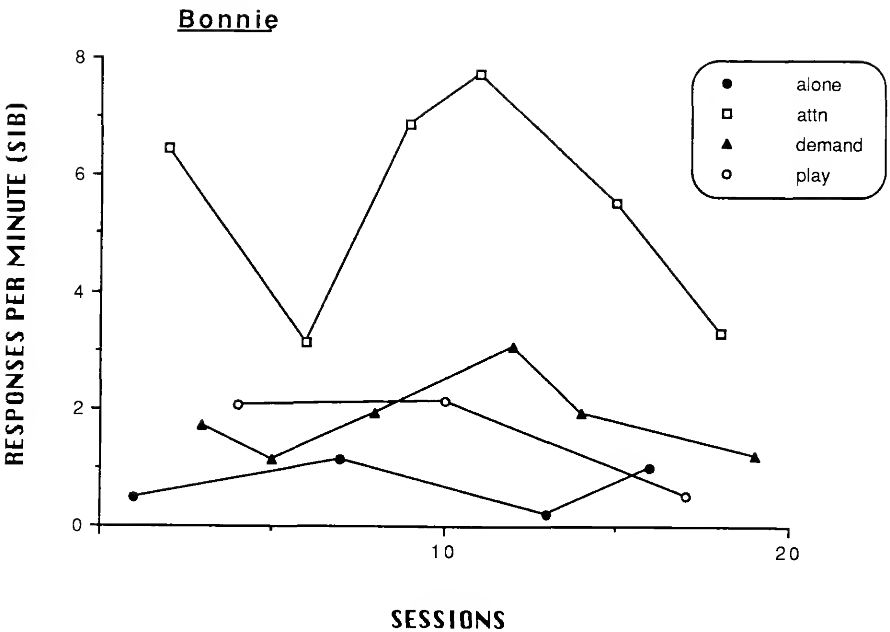
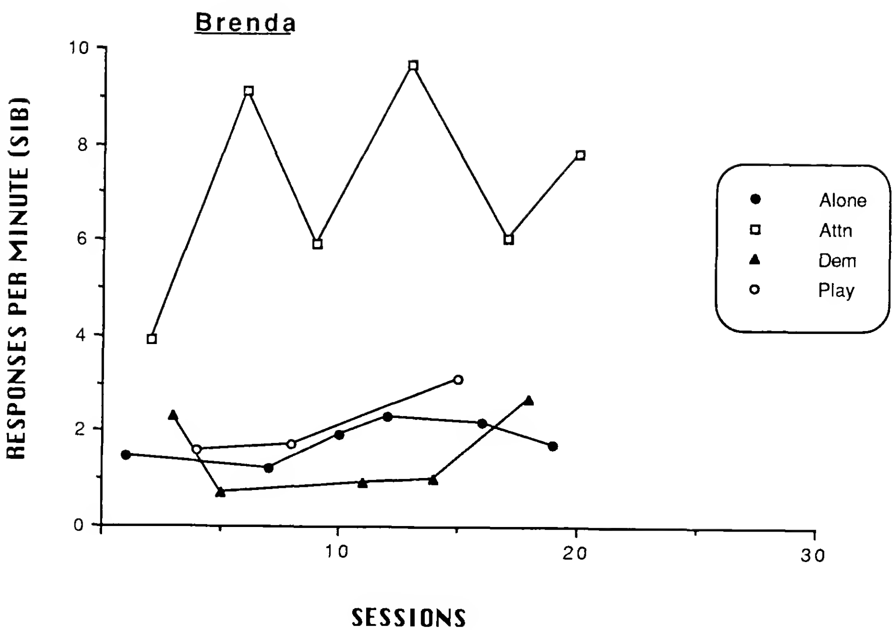

Bonnie
RESPONSES PER MINUTE (SIB)
0
2
4
6
8
10
20
SESSIONS
alone
attn
demand
play

Figure 6. Responses per minute (SIB) during the functional analysis of Brenda's SIB.



Brenda
RESPONSES PER MINUTE (SIB)
10
8
6
4
2
0
10
20
30
SESSIONS
Alone
Attn
Dem
Play

differentially sensitive to attention as a reinforcing consequence. Collectively, the results of these functional analyses ensured that the subjects were appropriate participants in the treatment comparison. Specifically, behavior maintained by attention (positively reinforced SIB) was seen as the relevant target response for DRO and NCR as treatments.

Treatment Comparison

Figure 7 shows the results of Diane's and Bonnie's treatment. For Diane (upper panel), the rate of SIB during baseline ranged from approximately 3 responses per minute to approximately 12 responses per minute. Following the introduction of treatment, both DRO and NCR were shown to be effective in reducing the rate of SIB. However, NCR initially suppressed SIB more effectively than DRO. In DRO, the rate of SIB was initially variable and there were several sessions with high rates of SIB. Eventually, the rate of SIB decreased to 0 responses per minute during most sessions in both treatment conditions.

For Bonnie (lower panel of Figure 7), the rate of SIB during baseline ranged from approximately 3 responses per minute to approximately 9 responses per minute. Following the introduction of treatment, both procedures resulted in immediate reductions in the rate of SIB, although DRO showed a more consistent suppressive effect throughout most of the treatment phase. During the final stages of treatment, both procedures were equally effective in suppressing SIB.

Figure 8 shows the results of Brenda's treatment comparison. During baseline, the rate of SIB initially approximated the rate seen in Brenda's functional analysis but increased across the baseline to a level of nearly 50 responses per minute. Next, NCR was introduced and had a suppressive effect on SIB, and the rate of SIB remained

Figure 7. Comparison of DRO and NCR for Diane (top) and Bonnie (bottom) using an alternating treatments within-subjects experimental design and multiple baseline across-subjects experimental design.

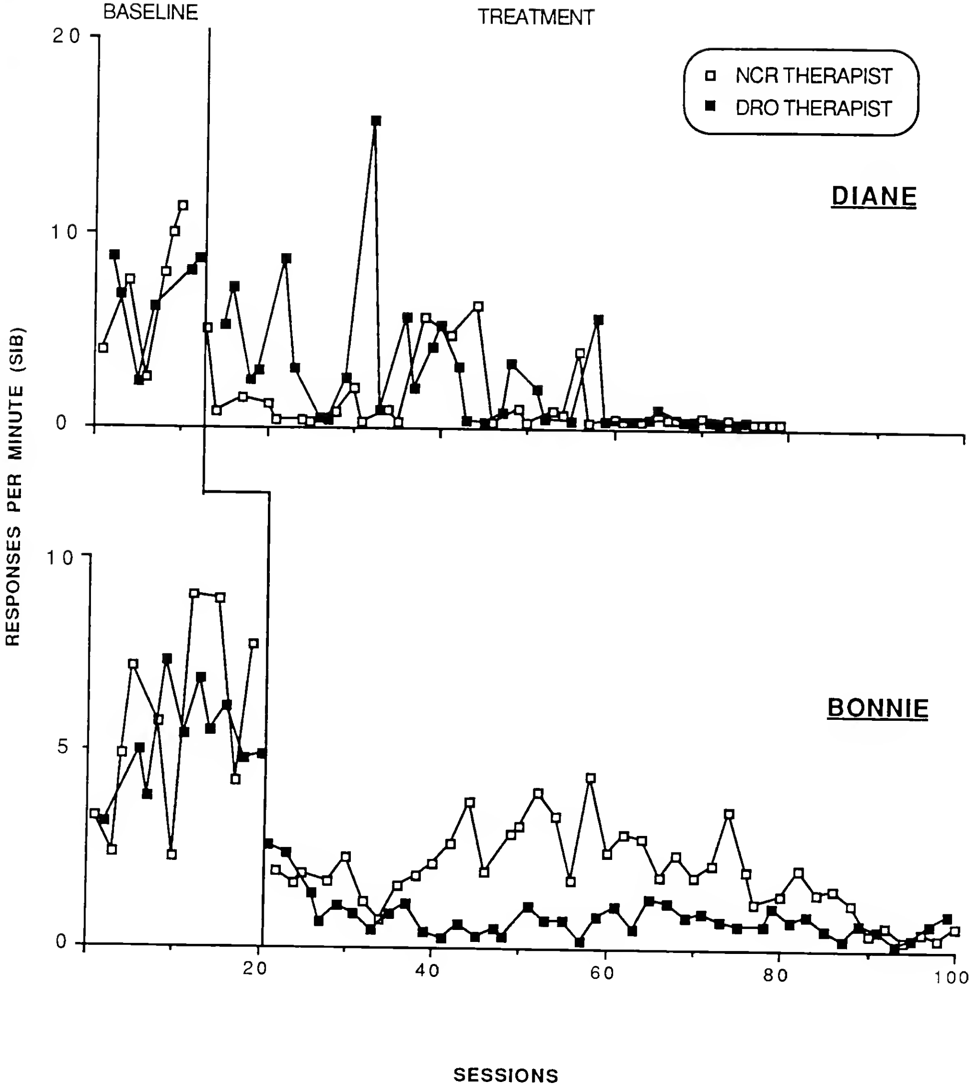
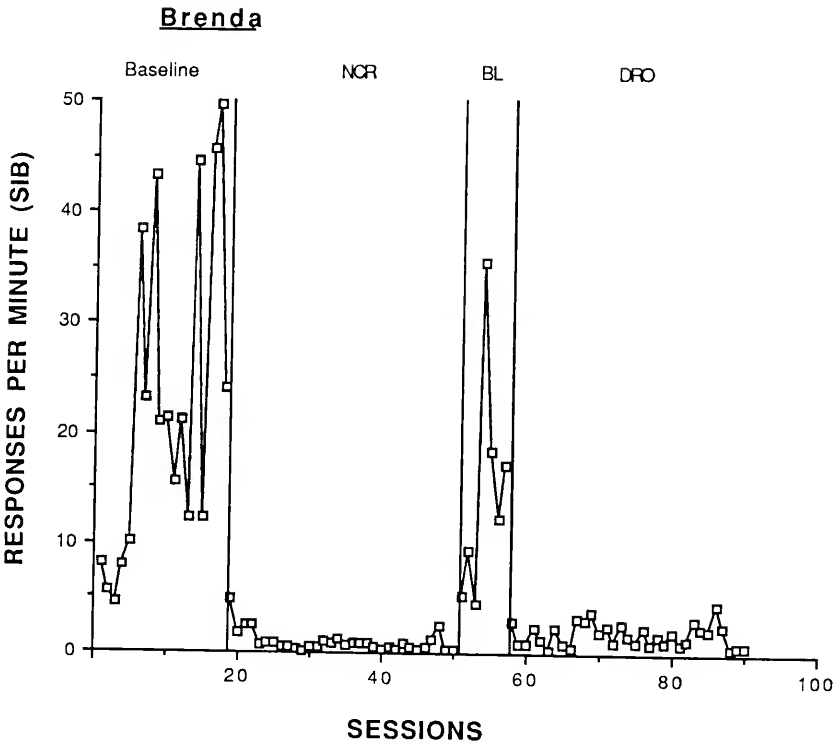

BASELINE
TREATMENT
NCR THERAPIST
DRO THERAPIST
DIANE
BONNIE
RESPONSES PER MINUTE (SIB)
SESSIONS
20
10
0
10
5
0
20
40
60
80
100

Figure 8. Comparison of DRO and NCR for Brenda, using a reversal experimental design.


Brenda
Baseline
NCR
BL
DRO
RESPONSES PER MINUTE (SIB)
0
10
20
30
40
50
20
40
60
80
100
SESSIONS

low throughout the entire condition. A return to baseline resulted in an increase in SIB. Finally, DRO also suppressed SIB, although the overall rate was slightly higher and more variable than it had been in NCR.

Table 1 shows the schedule changes for Diane's programmed reinforcer deliveries. During NCR, all schedule changes followed sessions during which the rate of SIB was below 0.5 responses per minute. The programmed schedule is not listed for NCR because, by definition, that schedule matches the actual rate of reinforcer delivery at each step (i.e., it is a fixed-time schedule). During DRO, intervals were increased to match the mean IRT for the preceding three sessions. Because the DRO interval advanced so rapidly for Diane, the mean IRT was calculated for the preceding five sessions for the other 2 subjects.

Table 2 shows the schedule changes for Bonnie's programmed reinforcer deliveries. Because Bonnie's SIB rarely fell below a rate of 0.5 per minute during NCR, the schedule was advanced when the rate of SIB fell within the range of the preceding several sessions and no upward trend was detectible. As with Diane, the programmed schedule is not listed for NCR because that schedule matches the actual rate of reinforcer delivery. During DRO, intervals were increased to match the mean IRT for the preceding 5 sessions until session 86, at which point intervals were advanced when the rate of SIB fell within the range of the preceding several sessions and no upward trend was detectible. It is noteworthy that when the DRO interval reached 5 minutes, Bonnie received only a total of 2 reinforcers over the course of 4 sessions (mean rate of reinforcement=0.03 per minute).

Table 3 shows the schedule changes for Brenda's programmed reinforcer deliveries. During NCR, all schedule changes followed sessions during which the rate of SIB was below 0.5 responses per minute. For the same reasons specified above, the programmed schedules of reinforcer delivery (in NCR) are not listed in the

table. During DRO, intervals were increased to match the mean IRT for the preceding five sessions until session 74, at which point intervals were advanced when the rate of SIB fell within the range of the preceding several sessions and no upward trend was detectible. It is noteworthy that the DRO interval could not advance past three minutes because the schedule became an extinction schedule at that point-- Brenda never had an interval of 3 minutes without SIB, and therefore reinforcers could not be delivered according to the resetting DRO schedule.

Table 1
Reinforcer schedule changes for Diane

NCR

	INTERVAL	SESSIONS	MEAN RATE OF SR+
	-	19, 20	6.00/min
	-	23,26,27	5.00/min
	-	30	4.00/min
	-	31	3.00/min
	-	34	2.00/min
	-	36,37	1.00/min
	-	40,41	0.50/min
	-	44-52	0.33/min
	-	55,56	0.25/min
	-	59-end	0.20/min
DRO			
	0:10	21,22,24	2.52/min
	0:15	25-32	1.57/min
	1:00	35	0.20/min
	1:10	38-53	0.32/min
	5:00	54-end	0.08/min

Table 2
Reinforcer schedule changes for Bonnie

NCR

INTERVAL	SESSIONS	MEAN RATE OF SR+
-	22-57	6.00/min
-	59,61,63	5.00/min
-	65,67	4.00/min
-	69,71	3.00/min
-	73,75,77	2.00/min
-	78	1.00/min
-	81	0.50/min
-	83,85	0.33/min
-	87,89	0.25/min
-	91-end	0.20/min

DRO

INTERVAL	SESSIONS	MEAN RATE OF SR+
0:10	21	1.93/min
0:15	23,26	2.13/min
0:20	27	1.73/min
0:25	29	1.33/min
0:35	31	1.20/min
0:45	33	1.00/min
1:05	35	0.53/min
1:15	37,39	0.37/min
1:20	41	0.40/min
1:35	43,45	0.40/min
1:50	47	0.40/min
2:20	49	0.20/min
2:25	52-84	0.16/min
3:00	86	0.14/min
4:00	88,90	0.11/min
5:00	92-end	0.03/min

Table 3
Reinforcer schedule changes for Brenda

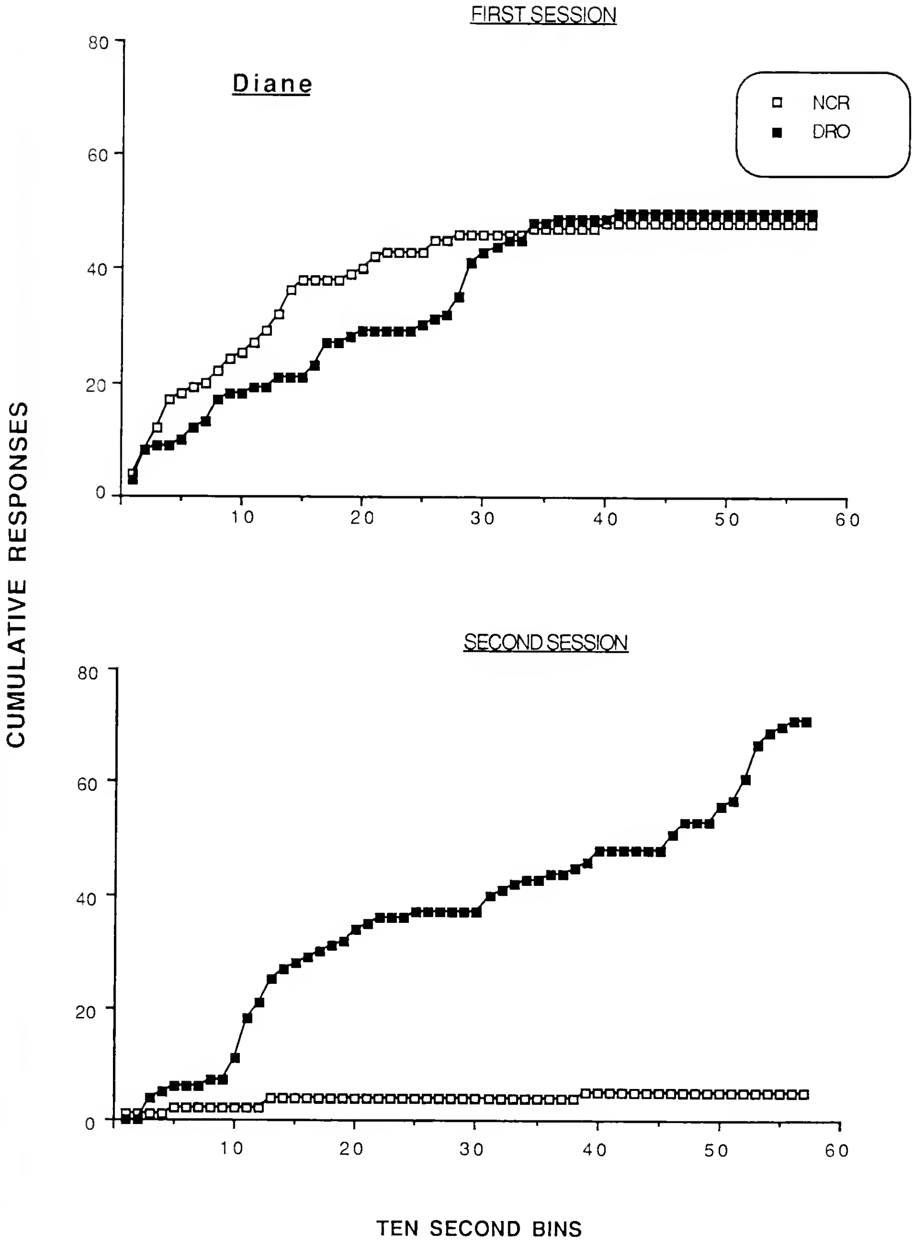
	INTERVAL	SESSIONS	MEAN RATE OF SR+
NCR			
	-	19-26	6.00/min
	-	27,28	5.00/min
	-	29	4.00/min
	-	30,31	3.00/min
	-	32-37	2.00/min
	-	38,39	1.00/min
	-	40	0.50/min
	-	41,42	0.33/min
	-	43,44,45	0.25/min
	-	46-50	0.20/min
DRO			
	0:10	58-62	2.68/min
	0:35	63	1.27/min
	0:50	64,65,66	0.57/min
	0:55	67-74	0.35/min
	1:00	75-79	0.52/min
	2:00	80,81,82	0.15/min
	3:00	83-end	0.00/min

DISCUSSION

The results of this study demonstrate that both DRO and NCR can be effective treatment procedures when SIB is maintained by socially-mediated positive reinforcement. These findings suggest that previously discrepant results with DRO and NCR procedures might be due to a failure to use a function-based approach to treatment. The results are particularly interesting in light of the fact that NCR has been used as a "control" procedure to demonstrate the effects of DRO (e.g., Corte et al., 1971). In general, because NCR was ultimately as effective as DRO, the contingent nature of reinforcement delivery in DRO may be of significance only if arbitrary positive reinforcers are used. However, Bonnie's results suggest that this finding should be viewed with caution because DRO was consistently more effective than NCR until both reinforcer-delivery intervals approached 5 minutes.

Because NCR was eventually as effective as DRO, there are several reasons why NCR might be considered a superior treatment. As described previously, an inherent feature of a function-based DRO is the witholding of reinforcement, which might produce extinction-induced responding under some circumstances (see Cowdery et al., 1990). In this study, none of the subjects displayed noticeable emotional behavior, such as crying, in either treatment condition. However, there is some reason to believe that NCR attenuated the undesirable effects of extinction for two of the three subjects. Figure 9 shows the cumulative number of self-injurious responses for Diane's first two sessions in each condition. In the first session, for

Figure 9. Cumulative responses within the first two sessions of DRO and NCR for Diane.

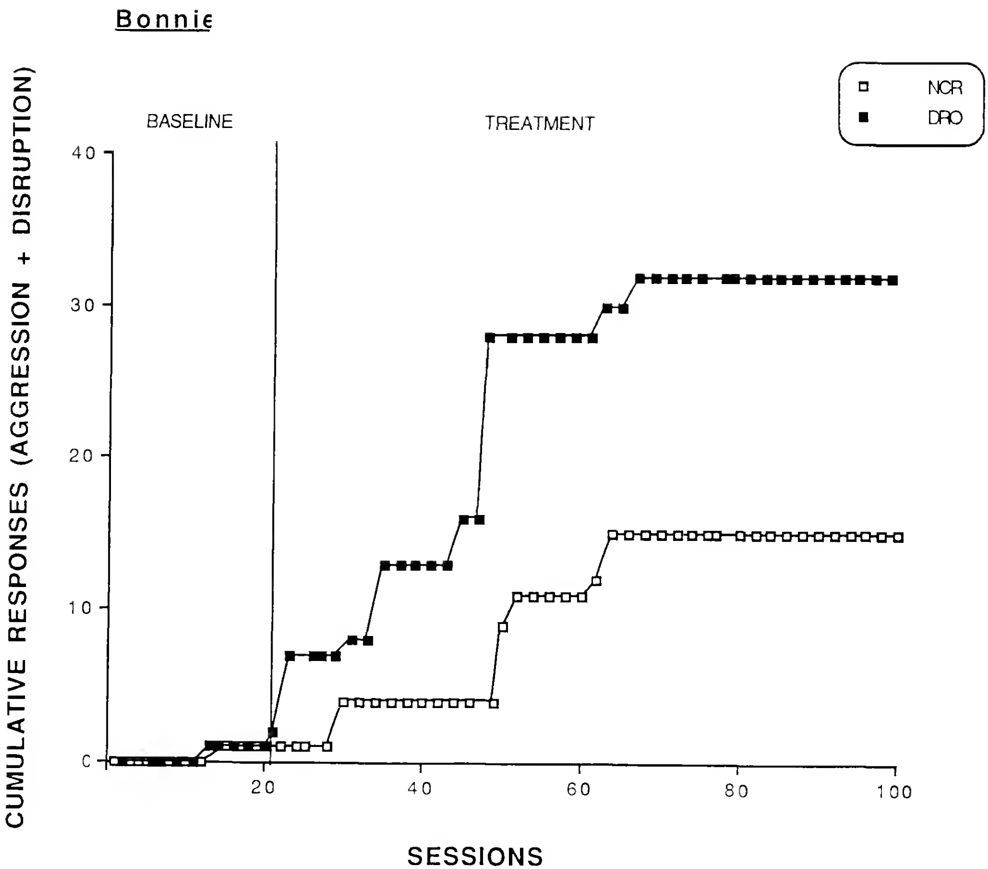

FIRST SESSION
Diane
NCR
DRO
80
60
40
20
0
10
20
30
40
50
60
SECOND SESSION
80
60
40
20
0
10
20
30
40
50
60
CUMULATIVE RESPONSES
TEN SECOND BINS

both NCR and DRO, there was a burst of responding at the beginning of the session, which eventually subsided during the last one-third of the session. In session two, there was another burst of responding in DRO, which persisted throughout much of the session; in NCR, very little responding occurred from the outset of the second session. This finding could be interpreted as evidence for an extinction burst in DRO, with less of a burst in NCR.

As further evidence, Figure 10 shows the cumulative number of aggressive and disruptive responses displayed by Bonnie during baseline and during both treatment conditions. There were no programmed consequences for either aggression or disruption, and both of those types of behavior occurred infrequently during baseline. More aggression and disruption were seen during the DRO condition-- although such responses eventually stopped occurring. A common result of extinction procedures is an increase in aggression and in response variation (Skinner, 1953). Possibly, Bonnie's aggression and disruption were a direct result of the extinction components of treatment. Thus, for Diane and Bonnie, there is tentative evidence suggesting that NCR attenuates extinction-induced phenomena. No such evidence exists for Brenda, because she was far more aggressive and disruptive during baseline than during either treatment condition, and no bursts in responding were observed.

Another advantage of NCR over DRO in this study was that, at comparable interval lengths, the rate of reinforcer delivery was relatively higher in NCR. This is so because NCR contains no resetting feature and the schedule is unaffected by the subject's behavior. Tables 1, 2, and 3 show the relatively higher rate of reinforcer delivery in NCR. At the terminal reinforcement interval, for all three subjects, the rate of delivery is considerably higher. Bonnie (Table 2) received only two reinforcers across a four session span in DRO-- a schedule that approximates an

Figure 10. Cumulative number of aggressive and disruptive responses across sessions for Bonnie.


Bonnie
NCR
DRO
BASELINE
TREATMENT
CUMULATIVE RESPONSES (AGGRESSION + DISRUPTION)
40
30
20
10
0
20
40
60
80
100
SESSIONS

extinction procedure without a differential reinforcement component. Brenda's schedule (Table 3), in fact, became an extinction schedule when the DRO interval was changed to 3 minutes. This can be seen as a significant shortcoming of DRO because, even at intervals as short as 3 minutes, it is possible that some subjects would rarely or never recieve social interaction if it contingently delivered throughout the day.

A final advantage of NCR is ease of implementation. In DRO, a caregiver must observe each instance of SIB to ensure that the resetting schedule is implemented correctly. This is not true for NCR because the schedule is unaffected by the subject's behavior. This is a particularly important point for caregivers responsible for monitoring and delivering treatment for several students or clients at once, such as in classrooms or institutional settings.

Several research questions arise from the current study. Because the NCR procedure contained a variety of features, it is unclear which component or components were responsible for behavior change. For example, it is unknown whether it was necessary to start the NCR condition with continuous attention and then fade to a less dense schedule. It is possible that intermittent presentations of attention would have reduced occurrences of SIB (see Mace & Lalli, 1991). Also, the effects could have been a result of a relatively dense schedule of reinforcer delivery in comparison to DRO. In this study, the rates of reinforcer delivery in NCR were not yoked to the rate of reinforcer delivery in DRO because the non-resetting feature of NCR was seen as an inherent advantage of the procedure that should be explored. To yoke the rate of reinforcer delivery would have been to imbue NCR with one of the limitations of DRO. However, future research could control for rate of reinforcer delivery and compare the relative effects of the two procedures for the purposes of a component analysis.

Also unclear is whether the effects of NCR are a result of extinction (because the contingent relationship between SIB and attention was eliminated) or a result of satiation (because attention was provided on a relatively rich schedule). It is likely that some combination of the two processes was in effect. In Brenda's case, during baseline, responding continued at rates up to 50 responses per minute, suggesting that her "satiation point" for attention was very high. As such, it is unlikely that when attention was delivery non-contingently at five minute intervals the obtained effects were solely a function of satiation. Also, when her DRO schedule was increased to 3 minutes and extinction was in effect, higher rates of SIB were seen than in the terminal phase of NCR, suggesting that more than just extinction was influencing the rate of SIB during NCR.

To the extent that NCR attenuates a relative state of deprivation, the current study extends previous findings in the treatment of escape behavior to the treatment of positively reinforced behavior. Specifically, Pace, Iwata, Cowdery, Andree, & McIntyre (1991) demonstrated that when the establishing operation for escape as negative reinforcement (the presentation of instructional demands) was completely removed from the environment, escape SIB did not occur. By fading in the frequency of demands, the experimenters were able to maintain low rates of SIB. Similarly, the current study began by eliminating the relevant establishing operation (deprivation from attention) by providing attention continuously. The schedule of attention was then gradually made more lean while maintaining a low rate of SIB.

A finding of this study that is somewhat surprising is that adventitious reinforcement (Skinner, 1948) was not problematic in the NCR condition. It might seem that some attention would incidentally follow SIB and, hence, reinforce its occurrence. There was partial evidence of this phenomenon is Bonnie's case, because there was some level of SIB throughout most of the NCR treatment. Additionally, a

review of the time course of Bonnie's SIB showed that the behavior occurred most frequently within 10-seconds after attention delivery, suggesting that Bonnie's history of reinforcement was such that therapist presence was discriminative for further attention. As Morse and Kelleher (1977) pointed out, it is likely that baseline schedules of reinforcement are important factors in the adventitious maintenance of responding. In this case, SIB was reinforced on a continuous (CRF) schedule during baseline, and the eventual schedule of reinforcer delivery in NCR was very different (and presumably highly discriminable) from that baseline schedule. If SIB had been reinforced on an intermittent schedule in baseline, and NCR produced intermittent accidental reinforcer deliveries, adventitious reinforcement may have been more likely. In Brenda's case, however, because baseline rates of SIB were so high, there was also nearly continuous attention provided during baseline. Interestingly, when the condition changed to continuous NCR, SIB persisted for approximately the first four minutes of the session-- at which time Brenda paused and attention was still delivered. This pattern continued for several sessions, with the duration of near-continuous bouts of responding becoming progressively shorter across sessions. This finding further supports the notion that similarity in scheduled reinforcer deliveries might produce adventitious reinforcement.

In cases when a baseline CRF schedule is impractical or impossible, designing schedules of reinforcer delivery to combine the features of NCR and DRO might be useful to avoid adventitious reinforcement. For example, a non-resetting DRO interval (Repp et al., 1976) might be used, which would increase the likelihood of the subject receiving at least some attention, yet no instances of the target response would be followed by attention. Perhaps even better, a momentary time sample of behavior could be conducted on a fixed-time schedule, and if the subject was not

engaging in SIB at that moment, attention could be delivered (see Repp, Barton, & Brulle, 1983).

Apart from the possibility of accidental reinforcement, another limitation of NCR is that, like DRO, it does not explicitly promote alternative adaptive behavior. This limitation could easily be overcome in future applications; the procedure could incorporate the shaping of some alternative attention-getting response. In fact, each of the subjects of this study eventually became involved in treatment procedures that included the reinforcement of alternative behavior. Thus, there is nothing in principle about NCR that precludes contingent reinforcement as a component of a treatment package.

Further research could also explore the possibility that NCR is not necessarily limited to applications involving behavior maintained by positive reinforcement. For example, intermittent noncontingent escape (breaks) from instructional demands might reduce undesirable escape behavior. Previous demand-fading studies have contained an escape-extinction component and made escape from demands contingent on the absence of self-injury (e.g., Pace et al., 1991; Zarcone, 1990). Similarly, when behavior is automatically reinforced, it is possible that response independent access to alternative sources of stimulation would reduce stereotyped responding, assuming the alternative stimulation is similar in nature to the functional response-produced stimulation; such an interpretation is relevant to the "environmental enrichment" approach described by Horner (1980). An examination of these issues across behavioral functions is warranted.

To conclude, this study demonstrated that both DRO and NCR can be effective treatments for aberrant behavior. Previously discrepant findings with these procedures probably result from a failure to identify behavioral function and the use of arbitrary reinforcers. Because there are several practical advantages to NCR

over DRO, clinicians are provided with an alternative reinforcement-based procedure. Furthermore, NCR could be used as one component of a more extensive treatment package; this possibility was not examined in the current study because preliminary experimentation involving NCR alone was seen as a necessary prerequisite to future applications. On a theoretical level, this study brings into question the necessity of providing reinforcement contingent on the absence of responding and questions the place of differential reinforcement on any hierarchy of restrictive treatment. That is, DRO can result in a very low frequency of attention, which functionally resembles a contingent reinforcer-loss procedure.

REFERENCES

Allen, K.E., & Harris, F.R. (1966). Elimination of a child's scratching by training the mother in reinforcement procedures. Behaviour Research and Therapy, 4, 79-84.

Azrin, M., Rubin, H., O'Brien, F., Ayllon, T., & Roll, D. (1968). Behavioral engineering: Postural control by a portable operant apparatus. Journal of Applied Behavior Analysis, 1, 99-108.

Boe, R.B. (1977). Economical procedures for the reduction of aggression in a residential setting. Mental Retardation, 15, 25-28.

Bostow, D.E., & Bailey, J.S. (1969). Modification of severe disruptive and aggressive behavior using brief timeout and reinforcement procedures. Journal of Applied Behavior Analysis, 2,31-37.

Bryson, Y., Sakati, N., Nyhan, W.L., & Fish, C.H. (1971). Self-mutilative behavior in the Cornelia de Lange Syndrome. American Journal of Mental Deficiency, 76, 319-324.

Buell, J., Stoddard, P., Harris, F.R., & Baer, D.M. (1968). Collateral social development accompanying reinforcement of outdoor play in a preschool child. Journal of Applied Behavior Analysis, 1, 167-173.

Carr, E.G. (1977). The motivation of self-injurious behavior: A review of some hypotheses. Psychological Bulletin, 84, 800-816.

Carr, E.G., & McDowell, J.J. (1980). Social control of self-injurious behavior of organic etiology. Behavior Therapy, 11, 402-409.

Carr, E.G., Newsom, C.D., & Binkoff, J.A. (1976). Stimulus control of self-destructive behavior in a psychotic child. Journal of Abnormal Child Psychology, 4, 139-153.

Cooper, J.O., Heron, T.E., & Heward, W.L. (1987). Applied behavior analysis. Columbus, Oh.: Merrill Publishing Company.

Corte, H.E., Wolf, M.M., & Locke, B.J. (1971). A comparison of procedures for elimination of self-injurious behavior of retarded adolescents. Journal of Applied Behavior Analysis, 4, 201-213.

Cowdery, G.E., Iwata, B.A., & Pace, G.M. (1990). Effects and side effects of DRO as treatment for self-injurious behavior. Journal of Applied Behavior Analysis, 23, 497-506.

Day, R.M., Rea, J.A., Schussler, N.G., Larsen, S.E., & Johnson, W.L. (1988). A functionally based approach to the treatment of self-injurious behavior. Behavior Modification, 12, 565-589.

Deitz, D.E.D., & Repp, A.C. (1983). Reducing behavior through reinforcement. Exceptional Education Quarterly, 3, 34-46.

DeLissovoy, V. (1962). Head banging in early childhood. Child Development, 33, 43-56.

DeLissovoy, V. (1963). Head banging in early childhood: A suggested cause. Journal of Genetic Psychology, 102, 109-114.

Doubros, S.G., & Daniels, G.J. An experimental approach to the reduction of overactive behavior (1966). Behaviour Research and Therapy, 4 , 251-258.

Durand, V.M., & Carr, E.G. (1991). Functional communication training to reduce challenging behavior: Maintenance and application in new settings. Journal of Applied Behavior Analysis, 24, 251-264.

Favell, J.E., Azrin, N.H., Baumeister, A.A., Carr, E.G., Dorsey, M.F., Forehand, R., Foxx, R.M., Lovaas, O.I., Rincover, A., Risley, T.R., Romanczyk, R.G., Russo, D.C., Schroeder, S.R., Solnich, J.V. (1982). The treatment of self-injurious behavior. Behavior Therapy, 13, 529-554.

Favell, J.E., McGimsey, J.F., & Schell, R.M. (1982). Treatment of self-injury by providing alternative sensory activities. Analysis and Intervention in Developmental Disabilities, 2, 83-104.

Goetz, E.M., Holmberg, M.C., & LeBlanc, J.M. (1975). Differential reinforcement of other behavior and noncontingent reinforcement as control procedures during the modification of a preschooler's compliance. Journal of Applied Behavior Analysis, 8, 77-82.

Griffin, J.C., Williams, D.E., Stark, M.T., Altmeyer, B.K., & Mason, M. (1986). Self-injurious behavior: A state-wide prevalence survey of the extent and circumstances. Applied Research in Mental Retardation, 7, 105-116.

Homer, A.L., & Peterson, L. (1980). Differential reinforcement of other behavior: A preferred response elimination procedure. Behavior Therapy, 11 , 449-471.

Horner, R.D. (1980). The effects of an environmental "enrichment" program on the behavior of institutionalized profoundly retarded children. Journal of Applied Behavior Analysis, 13, 473-491.

Iwata, B.A., Dorsey, M.F., Slifer, K.J., Bauman, K.E., & Richman, G.S. (1982). Toward a functional analysis of self-injury. Analysis and Intervention in Developmental Disabilities, 2, 1-20.

Iwata, B.A., Pace, G.M., Kalsher, M.J., Cowdery, G.E., & Cataldo, M.F. (1990). Experimental Analysis and extinction of self-injurious escape behavior. Journal of Applied Behavior Analysis, 23, 11-27.

Iwata, B.A., Pace, G.M., Kalsher, M.J., Cowdery, G.E., Cataldo, M.F., McCosh, K.C., Willis, K.D., Rodgers, T.A., Zarcone, J.R., Vollmer, T.R., Smith, R.G., & Mazaleski, J.L. (1991). The functions of self-injurious behavior: An experimental-epidemiological analysis. Paper presented at the 17th annual convention of the association for behavior analysis, Atlanta, Georgia, May, 1991.

Iwata, B.A., Vollmer, T.R., & Zarcone, J.R. (1990). The experimental (functional) analsysis of behavior disorders: Methodology, applications, and limitations.In A.C. Repp and N.N. Singh (Eds.), Perspectives on the use of nonaversive and aversive interventions for persons with developmental disabilities. (pp. 301-330). Sycamore, Il: Sycamore Pubishing Company.

Johnson, W.L., & Rea, J.A. (1986). Self-injurious behavior treatment and research: A historical perspective. Advances in Learning and Behavioral Disabilities, 5, 1-23.

Lennox, D.B., Miltenberger, R.G., & Donnelly, D.R. (1987). Response interuption and DRL for the reduction of rapid eating. Journal of Applied Behavior Analysis, 20, 279-284.

Lennox, D.B., Miltenberger, R.G., Spengler, P., Erfanian, N. (1988). Decelerative treatment practices with persons who have mental retardation: A review of five years of the literature. American Journal on Mental Retardation, 92, 492-501.

Lovass, O.I., Newsom, C.D., & Hickman, C. (1987). Self-stimulatory behavior and perceptual reinforcement. Journal of Applied Behavior Analysis, 20, 45-68.

Lovaas, O.I., & Simmons, J.Q. (1969). Manipulation of self-destruction in three retarded children. Journal of Applied Behavior Analysis, 2, 143-157.

Luiselli, J.K. (1986). Behavior analysis of pharmacological and contingency management interventions for self-injury. Journal of Behavior Therapy and Experimental Psychiatry, 17, 275-284.

Mace, F.C., & Lalli, J.S. (1991). Linking descriptive and experimental analyses in the treatment of bizarre speech. Journal of Applied Behavior Analysis, 24, 553-562.

Maitso, C.R., Baumeister, A.A., & Maisto, A.A. (1978). An analysis of variables related to self-injurious behavior among institutionalized retarded persons. Journal of Mental Deficiency Research, 22, 27-36.

Malott, R.W., & Cumming, W.W. (1964). Schedules of interresponse time reinforcement. Psychological Record, 14, 221-252.

Michael, J. (1982). Distinguishing between discriminative and motivational functions of stimuli. Journal of the Experimental Analysis of Behavior, 37, 149-155.

Morse, W.H., & Kelleher, R.T. (1977). Determinants of reinforcement and punishment. In W.K. Honig & J.E.R. Staddon (Eds.). Handbook of operant conditioning (pp. 174-200). Englewood Cliffs, NJ: Prentice-Hall, Inc.

Nevin, J.A., Tota, M.E., Torquato, R.D., & Shull, R.L. (1990). Alternative reinforcement increases resistance to change: Pavlovian or operant contingencies? Journal of the Experimental Analysis of Behavior, 53, 359-379.

Nyhan, W.L. (1976). Behavior in the Lesch-Nyhan Syndrome. Journal of Autism and Childhood Schizophrenia, 6, 235-252.

Pace, G.M., Iwata, B.A., Cowdery, G.E., Andree, P.J., & McIntyre, T. (1991). Stimulus (demand frequency) fading during extinction of self-injurious escape behavior. Manuscript submitted for publication.

Patterson, G.R., Jones, R., Whittier, J., & Wright, M.A. (1965) A behaviour modification technique for the hyperactive child. Behaviour Research and Therapy, 2, 217-226.

Poling, A., & Ryan, C. (1982). Differential reinforcement of other behavior schedules: Therapeutic applications. Behavior Modification, 6 , 3-21.

Reid, D.H., Parsons, M.B., Green, C.W., & Schepis, M.M. (1991). Evaluation of components of residential treatment by medicaid ICF-MR surveys: A validity assessment. Journal of Applied Behavior Analysis, 24, 293-304.

Repp, A.C., Barton, L.E., & Brulle, A.R. (1983). A comparison of two procedures for programming the differential reinforcement of other behaviors. Journal of Applied Behavior Analysis, 16, 435-445.

Repp, A.C., & Deitz, S.M. (1974). Reducing aggressive and self-injurious behavior of institutionalized retarded children through reinforcement of other behavior. Journal of Applied Behavior Analysis, 7, 313-325.

Repp, A.C., Deitz, S.M., & Deitz, D.E.D. (1976). Reducing inappropriate behaviors in a classroom and in individual sessions through DRO schedules of reinforcement. Mental Retardation, 14, 11-15.

Repp, A.C., Deitz, S.M., & Speir, N.C. (1974). Reducing inappropriate behaviors in classrooms and in individual sessions through DRO schedules of reinforcement. American Journal of Mental Deficiency, 79 , 279-284.

Rescorla, R.A., & Skucy, J. (1969). Effect of response-independent reinforcement during extinction. Journal of Comparative and Physiological Psychology, 67, 381-389.

Reynolds, G.S. (1961). Behavioral contrast. Journal of the Experimental Analysis of Behavior, 4 , 57-71.

Rolider, A., & Van Houten, R. (1990). The role of reinforcement in reducing inappropriate behavior: Some myths and misconceptions. In A.C. Repp and N.N. Singh (Eds.), Perspectives on the use of nonaversive and aversive interventions for persons with developmental disabilities. (pp. 119-128). Sycamore, Il: Sycamore Pubishing Company.

Romanczyk, R.G. (1986). Self-injurious behavior: Conceptualization, assessment, and treatment. In K.D. Gadow (Ed.), Advances in learning and behavior disabilities (Vol. 5, pp.29-56). Greenwich, CT: JAI Press.

Romanczyk, R.G., & Goren, E.R. (1975). Severe self-injurious behavior: The problem of clinical control. Journal of Consulting and Clinical Psychology, 43, 730-739.

Schroeder, S.R., Schroeder, C.S., Smith, B., & Dalldorf, J. (1978). Prevalence of self-injurious behaviors in a large state facility for the retarded: A three year follow-up study. Journal of Autism and Childhood Schizophrevia, 8, 261-269.

Skinner, B.F. (1948). 'Superstition' in the pigeon. Journal of Expermental Psychology, 38, 168-172.

Skinner, B.F. (1953). Science and human behavior. New York: Macmillan.

Tate, B.G., & Baroff, G.S. (1966). Aversive control of self-injurious behavior in a psychotic boy. Behavioral Research and Therapy, 4, 281-287.

Uhl, C.N., & Garcia, E.E. (1969). Comparison of ommission with extinction in response elimination in rats. Journal of Comparative and Physiological Psychology, 69 , 554-562.

Vollmer, T.R., & Iwata, B.A. (1991). Establishing operations and reinforcement effects. Journal of Applied Behavior Analysis, 24, 279-291.

Vollmer, T.R., & Iwata, B.A. (1991). Differential reinforcement as a treatment for behavior disorders: Procedural and functional variations. Manuscript submitted for publication.

Whitman, T.L., Scibak, J.W, & Reid, D.H. (1983). Behavior modification with the severely and profoundly retarded: Research and application. New York: Academic Press, Inc.

Zarcone, J. (1990). A comparison of extinction versus extinction plus stimulus (demand) fading as treatments for self-injurious escape behavior. Unpublished master's thesis, The University of Florida, Gainesville.

Zeiler, M.D. (1968). Fixed and variable schedules of response-independent reinforcement. Journal of the Experimental Analysis of Behavior, 14, 275-286.

Zeiler, M.D. (1970). Other behavior: Consequences of reinforcing not responding. Journal of Psychology, 74, 149-155.

BIOGRAPHICAL SKETCH

I was born December 11, 1962, in Grand Haven, Michigan. I became interested in psychology and behaviorism at Westerern Michigan University, where I enrolled in a number of courses related to those topics. I completed my undergraduate work and received my Bachelor of Science degree from the University of Florida in 1985. In 1987 I enrolled at the University of Florida as a graduate student in psychology (experimental analysis of behavior). I was a teaching assistant for one year and a research assistant throughout my graduate career at the University. I hope to pursue a career in behavior analysis that includes teaching and research.

In 1986 I was married to Amy Metzgar. Our first child, Benjamin, was born in October, 1991.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Brian A. Iwata, Chairperson
Professor of Psychology

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Marc N. Branch
Professor of Psychology

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Vivian I. Correa
Associate Professor of Special Education

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Timothy D. Hackenberg
Assistant Professor of Psychology

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Carol Van Hartesveldt
Professor of Psychology

This dissertation was submitted to the Graduate Faculty of the Department of Psychology in the College of Liberal Arts and Sciences and to the Graduate School and was accepted as partial fulfillment of the requirements for the degree of Doctor of Philosophy.

May, 1992

____

Dean, Graduate School